CHAPTER 2

APPLYING VE

Criteria

If not used effectively, knowledge of VE techniques in itself is of little value. Like any profitable program or business, the successful VE program is based on an adequate return on investment. Normally a product line is selected on the basis of anticipated contribution to profit. Similarly the selection of VE projects should be based on the potential yield from the time, talent, and cost which will be invested. The selection procedure should rank possible projects in order of potential return and probability of implementation. This enables the manager to determine which projects are likely to be the best investment.

VE has been proved effective in environments such as the engineering laboratory, test facilities, procurement operations, construction projects, manufacturing facilities, and maintenance depots. It has been applied to a broad spectrum of items, procedures, systems, and equipment. The range continues to expand.

A VE program includes a planned and organized set of specific tasks that support (or apply the VE discipline to) all major cost elements of an organization. Well-defined procedures lead practitioners through the essential steps of the process, and the execution of these steps generally involves the participation and coordination of personnel with diverse backgrounds.

VE is directed toward analyzing the functions of an item. In this respect, it differs from most other cost reduction techniques. Some other techniques may reduce inherent quality by cheapening the product to reduce cost. The VE technique starts with a determination of the required function and then seeks lower cost alternatives to achieve that essential function. The objective is to identify and eliminate <u>unnecessary</u> cost without loss in needed quality or reliability.

Functional analysis develops a "statement of function" for each part or element of the item being analyzed. Such functions are classified as basic and secondary. A basic function is one that cannot be eliminated without degrading the usefulness of the end item. A secondary function is not essential to operate the item in its intended application but is a consequence of the selected design solution. Limiting secondary functions and minimizing the cost of basic functions results in an item of "best value" which is consistent with all performance, reliability, quality, maintainability, logistics support, and safety requirements. The term "best value" refers to the best relationship between worth and cost. In other words, a "best value" is represented by an item that reliably performs the required basic function at an appointed time and place and which has the lowest total cost.

The VII-program in the DoD includes activities which do not necessarily use the function analysis technique. For example, activities organized to support the DoD Component Breakout, Competition, and Spares Management initiatives may not utilize all of the elements of the VE job plan as explained later in this Handbook. Similarly a rewardable VECP is one that complies with the terms of the specific contract and applicable acquisition regulations. An acceptable VECP does not have to be the result of a VE study. Although purposeful application of VE methodology is the greatest source of VECP savings benefits, on occasion, serendipity may also produce a rewardable contract change with little or no engineering content.

Early vs Later VE

The life cycle of a system or equipment begins with the determination that an operational deficiency exists or a new military capability is needed. Figure II-1 illustrates a common situation in which the savings potential decreases as the program ages. Early VE tends to produce greater savings or "cost avoidance" for two reasons. First, more units are affected by the savings actions. Second, earlier changes lower implementation costs such as testing, modifications to production lines, retooling expenses, and changes to operational support elements (e.g., spares, manuals, maintenance facilities, etc.). VE should be accomplished as early as possible.

However, VE late in a program is precluded only in those rare instances where the cost of the VE effort and subsequent implementation would be-greater than the savings potential. While later VE normally adds implementation costs and may affect smaller quantities, such deterrents can be more than offset by improved performance through advances in technology, additional available resources, more time, etc. There are always some opportunities which offer net savings at any stage of a program. For instance, one contractor activity reports that it was advised that it was probably too late in one program to submit VECPs. Nevertheless the group persisted and submitted VECPs for an additional three years. Of the 22 VECPs submitted since the purported cutoff, 12 were implemented.

Opportunities for certain types of proposals are frequently enhanced later in the life cycle. For instance, deletion of quality assurance testing often camot be proposed until considerable experience is acquired and data gathered to prove that it is not harmful. In another case, management reports required to understand the complex situation early in a program may turn out to be unnecessary during later phases of the program.

The VE opportunity may be extended because the product life and total requirements are not known. Many items of defense material will be reprocured indefinitely. There is no way to estimate the total quantity that will be purchased. Examples are: clothing, ammunition, fire extinguishers, tires, etc. Many items, which entered the defense inventory in the past, were never value engineered. These items often benefit from a VE effort to the same extent as previously value-engineered products. The potential for VE savings on these items is great. Advances in technology or changes in user requirements provide a basis for potential savings greater than the cost of the study and subsequent implementation.

Thus, VE may be applied at any point in the life cycle of an item or system where it is profitable to do so. Selection of the most appropriate time is influenced by many factors. Two of the most important are the magnitude of the savings likely from the effort and the ease or difficulty with which VE may be applied. VE in early stages is characterized by benefits which are difficult to measure. Often resulting "cost avoidances?' are simply approximated. Later VE results in "before and after" examples whose savings may be forecast with greater accuracy.

VE SAVINGS POTENTIAL DURING LIFE OF A TYPICAL SYSTEM

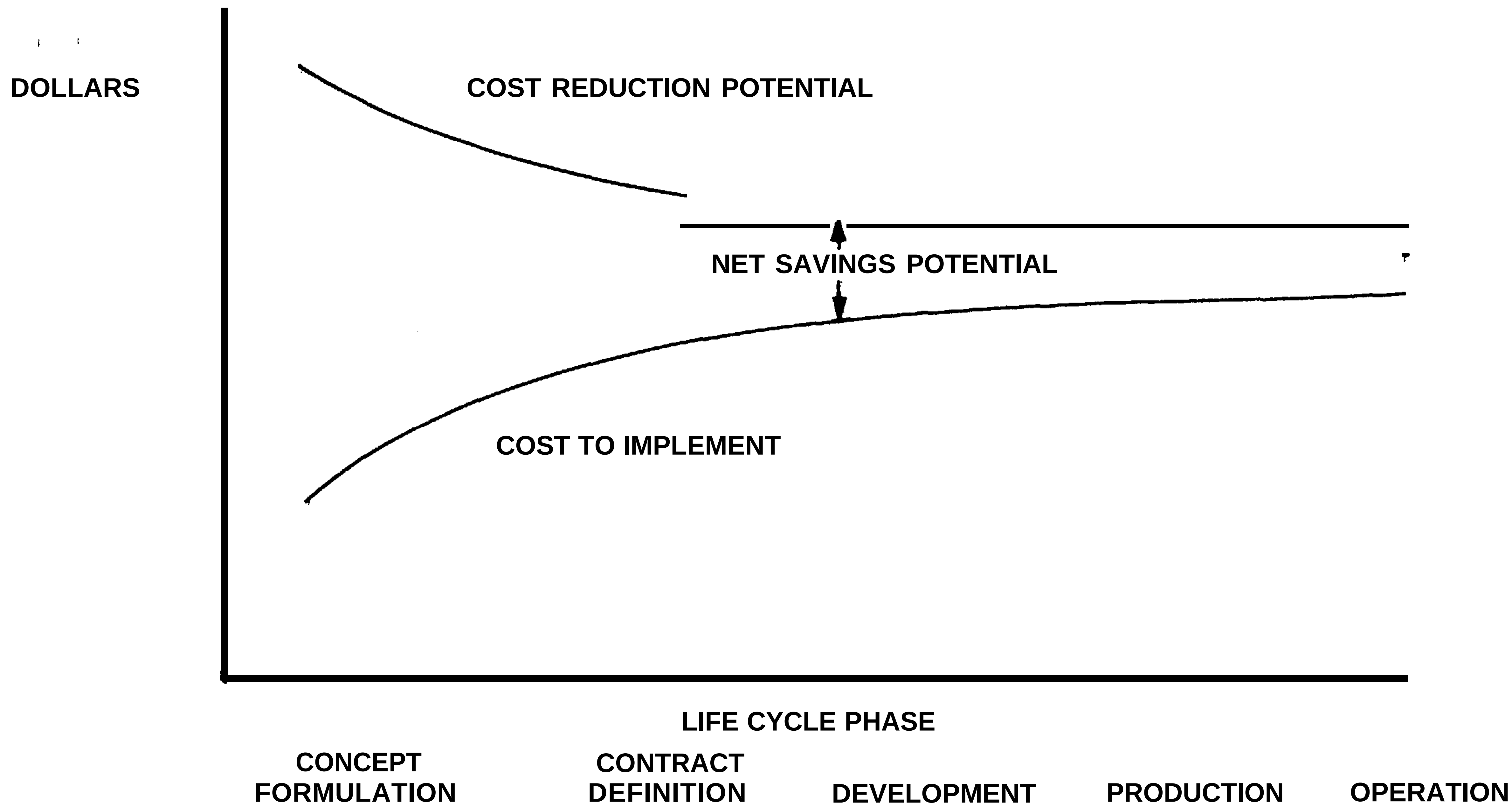

FIGURE 11-1

SOURCE: HELLER, E. D.,
GENERAL DYNAMICS
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CALIFORNIA 92112

Program Life Cycle

1. Concept Exploration Phase

The purpose of the concept exploration phase is to develop requirements and feasible concepts and define future operational and support requirements. Value improvement generated early in the life cycle produces benefits which may last throughout the life of the item or system. The engineering competence of VE personnel is of special importance in this phase. Analysis and decisions must often be made before the complete picture is available. The goal of low total cost (rather than just low acquisition cost) emphasizes the need for a VE organization competent in related acquisition, technical, and logistics fields. The VE effort in this phase furnishes guidance needed to assure the most economical early program and design decisions. Use of the VE program requirement clause is most useful in the early phases before full-scale engineering development (FSED) when there is no baseline from which to propose changes.

2. Demonstration and Validation Phase

The objective of the demonstration and validation phase is to ensure that the most promising system design concept(s) will be selected for FSED. During the validation phase, the contractors and Government can evaluate the system design concept(s) in terms of cost and value of operations, maintenance, test, and supply support functions. Significant improvements in total cost can be achieved through the performance of VE during this phase.

3. FSED Phase

The objective of this phase is to reaffirm the mission need and program objectives, complete the engineering design and ensure that system performance has been satisfactorily tested. VE can be used to analyze the essential requirements, military and technical characteristics, and the design tasks to develop possible alternatives offering improved value. Comparisons during this phase require special skills to validate the projected economic benefits. Evaluating initial prototypes, design layouts, and other details during the " development phase may provide additional opportunities to improve value. Efforts in this phase are directed toward evaluations and recommendations concerning function, cost, and worth of specifications, systems, modules, assemblies, parts, and components. By defining value in measurable terms, VE can produce a functional cost analysis to improve visibility of the costs directly related to detailed requirements. This capability is most useful in supporting design to cost producibility engineering and planning, and other similar programs. VE is also used to support engineering activities such as design reviews, test planning and evaluation, life cycle cost analysis, etc.

4. Production Phase

During the production phase, VE can be applied to evaluate manufacturing processes, methods, and materials. Equally applicable are support and test equipment, supply, "transportation and handling, technical data, facilities, maintenance, and training.

5. Operations Phase

Ownership cost is affected by operating, maintenance, and other logistics Costs. Reducing ownership costs (in excess of any attendant increase in acquisition cost) results in a lower total cost. Large potential savings often justify the investment for the VE study and subsequent implementation expenses during the operational phase. Studies during this phase offer an opportunity to make changes to incorporate new technology or to exploit mission or requirements changes. Sometimes new alternatives are a better choice than the item currently in the supply system.

Studies during the operational phase by contractors and DoD personnel have resulted in:

- Extension of item life by the application of new state-of-the-art designs, materials, or processes.
- Reduced repair costs by achieving the repair function in a more economical reamer.
- Reduction of packaging costs by improvements in packaging procedures or materials.
- Elimination of items.

Figure 11-2 summarizes the VE opportunities throughout the life cycle of a typical major program.

PROGRAM LIFE CYCLE OPPORTUNITY

Life cycle phase	System level	Program phase activity	Activity description
Concept Exploration	Mission	Function or objective	Clear definition of mission with stated function(s) or objectives in specific terms.
a. General operational	Mission performance characteristics.	System trade-off study, cost-effectiveness analysis, and value-engineering analysis	Review of mission requirement in terms of required performance. Review of existing system proposed systems involving advances in the state of the art.
b. Feasibility	System operational requirement.	Utility, go/no go determination	Program requirements baseline defined. Prepare system, subsystem, equipment, and component trade-off, initial cost/value effect, feasibility, and other studies consistent with mission and performance objectives.
Demonstration and Validation	System, subsystem equipment, and component.	System design, design trade-off studies, and specs required.	Expand operations, maintenance, test and activation functions. Determine additional design requirements for operations, Maintenance, test, and activation. Identify and perform trade-off studies. Identify applicable requirements and update source documentation.

Figure II-2

PROGRAM LIFE CYCLE 0PP0RTUN1T%

Life cycle phase	System level	Program phase activity	Activity description
			System requirement review (performance cost/value, design data, etc.)
			System design review.
			Technical evaluation and system engineering synthesis. Design requirements baseline defined.
			Subsystem, equipment and component design, and cost/value trade-off within functional/ performance specifications.
Full-Scale Engineering Development	Subsystem equipment and components	Subsystem design review and VE studies, test, and modification changes.	Design requirement baseline approved. Product configuration defined and approved. Conduct preliminary design reviews on operations/maintenance equipment and facilities.
Production	System, sub-equipment, and components	Evaluate manufacturing processes, methods, and materials	Conduct VE studies on manufacturing problems and contract requirements.
			Conduct critical design review on operations and maintenance equipment and facilities.
Operations (maintenance and logistic)	Equipment and component	Initial fabrication of changes (requiring Goverment approval and unilateral contr. changes)	Equipment and component review to further reduce cost within the established performance characteristics.

Figure II-2 (Continued)

Project Selection

Although the previous discussion focused on the VE opportunity throughout the life cycle of a typical hardware system, VE is not limited to hardware. Other possible VE opportunities within the defense environment include: materials, organizational functions, software, construction, technical data, etc. Almost anything within the assigned responsibility of an activity is a possible opportunity. In the early stages of a VE program, sophisticated project selection criteria are not usually needed. Frequently there are numerous areas for which the need for VE *is* obvious and which offer a substantial return on investment.

Those involved in beginning a new VE program or revitalizing a dormant one should select early projects that are most susceptible to VE. Initial projects should be selected that:

- Involve an ample dollar expenditure.
- Merit attention for reasons other than cost (i.e., deficiencies in performance, reliability, etc.).
- Are of interest to system or executive management.

As the VE program matures and the opportunities become less obvious, additional criteria may be used to select subsequent tasks. Guidelines for each specific possibility are far too numerous to be included in this Handbook. However, some additional characteristics usually exhibited by worthwhile candidates are:

- No known deterrents such as exorbitant test costs or implementation schedule requirements.
- A product with excessive complexity.
- A design that utilizes the most advanced technology.
- An accelerated development program.
- An item which field use indicates is deficient in some characteristics such as excessive failure rate or extravagant operating cost.
- An item utilizing older technologies for which modernization appears very promising.

Note that one of the attributes of VE is its ability to reveal to the rigorous user of the methodology cost improvement opportunities that might otherwise have remained invisible.

VE Job Plan"

For those interested in a more detailed discussion of the VE job plan, please refer to-Chapters V and VI of this Handbook. The VE job plan may be summarized as a systematic, step-by-step application of the general problem solving method: identify problem, solve problem, implement solution. Although there is no single best procedure, there are numerous ways in which VE techniques and practices can be supplemented, augmented, and adapted to conform to specific needs. Integrating these techniques and practices into a sequential procedure which is consistently productive is the core of the VE discipline. While the number of steps may vary, all job plans are characterized by an orderly progression through phases that include activities such as orientation, information, speculation, analysis, development and implementation, or something similar.

In the orientation phase, the project is selected and those who are going to work the problem are familiarized with it. Projects may be selected because they represent the greatest potential for savings or are characterized as a high-dollar (valuable) item or are needed in large quantities and therefore represent a considerable expense. Often projects are selected for reasons other than just savings potential or high cost.

The information gathering phase of the job plan includes researching the product selected to determine cost, function, and worth. The objectives of this research are: (1) to develop a thorough understanding of the item under study, and (2) to identify the specific value problem by including a functional analysis of the item accompanied by an estimate of the worth of each required function. Potential sources of factual information are drawings, manuals, specifications, cost and price information, work statements, and personal interviews.

During the speculation phase, creative-thinking techniques are used to develop alternative approaches that will accomplish the required functions. Such techniques may be either organized, forced, or free. Criticism of potential solutions must not be permitted, nor should alternatives be analyzed in this phase. A large number of alternatives is desirable. Often organized creativity sessions set goals of 75, 100, or even 200 fresh ideas in order to assure an adequate number.

All alternatives generated during the speculation phase are evaluated during the analysis phase against the functional criteria as well as examined for technical feasibility and cost. The alternatives are ranked. None are discarded. The most promising alternatives are selected for detailed evaluation and development. If none of those originally selected offer an acceptable solution, another set is selected and developed. The process is repeated until a solution is found.

In the development phase, final recommendations are developed from the alternatives selected during the analysis phase. Detailed technical and economic testing is conducted and the probability of successful implementation is assessed. The alternatives must be investigated in sufficient depth to permit the development of specific recommendations including an implementation plan. This must include making sure that the user's needs are satisfied; that the design is technically adequate; and that cost estimates, implementation expenses, and schedules are accurately estimated. Sound cost estimating is crucial when evaluating VE alternatives. It requires accurate information, expert judgments on cost allocations, and the inclusion of all Pertinent cost elements in the analysis. At the conclusion of this phase, one or more alternatives should be recommended for implementation and an implementation schedule yielding the greatest overall benefit should be constructed.

The presentation phase is actually presenting the best alternative (or alternatives) to those who have the authority to implement the proposed solutions that are acceptable. It includes preparing a formal VECP or value engineering proposal (VEP) that contains the information needed to reach a decision and implement the proposal.

During the implementation and follow-up phase, management must assure that approved recommendations are converted into actions. Until this is done, savings to offset the cost of the study will not be realized. Some degree of investment is usually required if a VE opportunity is to become a reality. Funds for implementation must be provided to support the actions necessary to capture the savings opportunity. Implementation progress' must be monitored just as systematically as proposal development. It is the responsibility of management to ensure that implementation is actually achieved. Often the VE focal point or program manager is responsible for monitoring milestone achievement in the implementation plan.

A VE project is not completed with implementation of an idea. Full benefit is not derived from a proposal until the follow-up is completed. Other applications of the proposal and actual results need to be established. Successful VE actions must be entered into the DoD VE data base and cost savings and other benefits reported through command channels. Until then, the records on a project cannot be closed.

A complete VE evaluation should answer the following questions:

A. Orientation:

-What is to be studied?

B. Information Gathering:

-What is it?
-What does it do?
-What does it cost?
-What is it worth?

C. Speculation:

-What else will do the job?

D. Analysis:

-What do the alternatives cost?
-Which is least expensive?

E. Development:

-Will the proposed alternative work?
-Will the proposed alternative meet requirements?
-What will the proposed alternative require?

F. Presentation:

- What is recommended?
- What are the alternatives?
- What will it cost?
- How much will it save?
- What is implementation schedule?

G. Implementation

- Has the proposal been approved, whole or in part, together with funding?
- Who is responsible for implementation?
- What actions have to be taken?
- Have completion dates been established?
- Have requirements for progress reporting been established?

H. Follow-Up:

- Did the idea work?
- Did it save money?
- Would you do it again?
- Could it benefit others?
- Has it been forwarded properly?
- Has it had proper publicity?
- Should any awards be made?
- Has it been listed in the VE-trieval or VE Data Information Storage and Retrieval System (VEDISARS) data bases?
- Has it been included in DoD VE savings reports?

Summa ry

The choice of techniques varies with the phase of the life cycle and the situation in which the VE study is initiated. Between the conceptual and operational phases of a product, the available time, talent, and factors to be considered change. Although VE studies conducted in the conceptual and validation phases may offer a maximum opportunity for value improvement, potential dollar savings are often difficult to validate since there is generally no cost base with which to compare cost improvements. VE may be profitably employed early in the life cycle to challenge basic requirements and analyze preliminary designs. Also, functional trade-offs, systems analysis, and operations research techniques play a greater role than in later VE. Cost-estimating techniques also differ significantly since some details of the design may have to be assumed. As a product progresses along its life cycle, the VE methodology must be adapted to conform to the situation and the available data. Something value engineered in the conceptual phase may offer additional opportunities later. This is particularly true if the applicable technology is rapidly changing, or if original development schedules did not include time for an adequate effort. Excellent opportunities exist to examine design requirements, development tests, operational tests, quality-assurance programs, and packaging requirements during the production phase. VE accomplished in the operational phase offers many opportunities for improvement in repair, packaging, and state-of-the-art materials, and process changes. Opportunities also exist in the operational phase for items which have never been reviewed or modernized.

Initially, VE projects may be selected on the basis of dollar volume, complexity, and degree of management support. Later, as projects with significant potential become less obvious, selection may be based on such additional factors as test costs, state of the art, degree of development, time compression, and field-problem reports. The VE job plan is the framework upon which a successful effort is built. When utilized properly, it assures a systematic approach to the identification and capture of a value opportunity. It provides for a thorough understanding of the subject including a quantitative identification of the nature and worth of the functional requirements. Uninhibited creative effort then may suggest alternative approaches to achieve all functions needed by the user. This is followed by a series of evaluations to select, develop, and implement the alternative offering the best opportunity for value improvement. No project is complete until proposals are implemented, results tallied, and new knowledge exploited as fully as possible.